

(whether the sensors be UST sensors or other types of sensors) of the device **10** so as not to, for example, generate unintended inputs due to the presence and/or movement of background objects, such as other parts of the user's body. Typically the sensing range will be less than about a meter, and more typically the value will be about, for example, 10-20 cm (or less). The maximum sensing range may typically be a function of the sensor technology. For example, the UST embodiments of this invention may typically have a greater detection/sensing range than the AMLCD embodiments discussed below. As can be appreciated, when the user places a finger or fingers, or a hand or hands, within the vicinity of the device **10**, "within the vicinity of the device" or sensing surface will be a volume of space, or a plane or more generally a surface, contained within the maximum useful sensing range of the sensing device(s) both in depth (away from the sensing surface) and lateral extent (within an area capable of being sensed from the sensing surface).

[0031] Note in FIG. 1A that the detected finger position may be translated and presented to the user by displaying two pointers (e.g., two crosses) **12A**, **12B** on the display **12**.

[0032] The described UST **14** system may serve to track the finger position of the user in 3D space and in real time. Visualization of the tracking (which may be used to provide perceptual feedback to the user) can be performed by showing one or more of the pointers **12A**, **12B** on the display **12**. This technique provides visual coordination to the user, and facilitates the manipulation of objects presented on the display **12** (such as icons and command bars). Furthermore, if a standard set of characters is shown on the display **12** the user may be provided with typewriting (keyboarding) capabilities, where a classical keyboard is replaced by a virtual keyboard. Tactile feedback (which appears in mechanical keyboards) can be replaced by, for example, short blinking of a finger "shadow" on the display **12** for indicating that a particular key has been accepted and the character inputted or a corresponding command executed. Furthermore, sound effects may be added to confirm that a certain command has been accepted.

[0033] In some applications, instead of detecting particular fingers, all or some of the entire hand can be detected. In other words, a displayed pointer (e.g., **12A**) can be associated to the center of gravity of the hand and used to drive/navigate the pointer. Such a configuration may significantly simplify the overall requirements (of hardware and software), and is particularly suitable in those cases when only a single pointer navigation/control is required.

[0034] FIG. 2 shows a further exemplary embodiment of this invention where the UST **14** system is incorporated into a device that embodies a mini-projector **30**, while FIG. 2B is a simplified block diagram of the mini-projector device **30** of FIG. 2A. Components that are found as well in FIG. 1 are numbered accordingly. The mini-projector device **30** includes a projector or projection engine **32** coupled to the DP **16** and projects an image **34** for viewing by the user. For the purposes of this invention the image **34** may be considered to be on a "display screen" or a "display surface". Pointers **34A**, **34B** corresponding to the locations of the user's fingers **20A**, **20B** can be displayed as well. The mini-projector device **30** may be linked via some wired or a wireless interface **36**, such as a Bluetooth transceiver, to a phone or other multimedia device **38**, and may display data sourced by the device **38**. The same or a similar UST **14**

scanning concept may be employed as in FIG. 1. Furthermore, the resulting user input system based on finger/hand placement and/or movement, combined with the projector engine **32**, maybe exploited for use in, for example, advanced gaming concepts that combine a large projected image and user gesture-based input. The use of a gesture-based language with the larger format displayed image **34** enables enhancements to be made to gaming concepts, as well as the design of games based on dynamical user movements in 3D.

[0035] The use of real-time finger tracing and the presentation of attributed pointers on the display/projector image **12/34** can be used to determine basic object-oriented or gesture-oriented commands. Commands such as: Select, Copy, Paste, Move, Delete and Switch may be applied on different displayed objects (such as icons, boxes, scroll-bars and files). These may be classified as object-oriented and gesture/browsing oriented operations, as follows in accordance with several non-limiting examples.

[0036] Object-Oriented:

[0037] Select:—Finger **1** at a display corner or some reserved area —Finger **2** moves slowly under a displayed object to be selected

[0038] Copy:—when selected click by single finger on the object

[0039] Paste:—fast double click by a single finger

[0040] Move:—move slowly two fingers located on the moving object

[0041] Delete:—double (fast) click by two fingers on previously selected object

[0042] Switch:—switching (on/off) is based on change in direction of fingers movement or, alternatively, on a change in finger acceleration.

[0043] Gesture/Browsing-Oriented:

[0044] Select object attributed to the pointer position: Open/closed hand (see FIGS. **3A**, **3B**)

[0045] Forward/Backward Browsing: anticlockwise/clockwise cyclic rotation by a single finger (see FIGS. **4A-4D**)

[0046] Zoom In/Out: Expand/Close Two Fingers (see FIGS. **5A**, **5B** and **8D**)

[0047] Run/Execute pre-selected icon/command: make a circle with two fingers (see FIG. **6**).

[0048] The exemplary gesture protocols described above enabling manipulation of objects on the display **14** (or the projected display **34**, by finger movements or gestures. These exemplary protocols provide a large capacity and design freedom for gesture-based commands and language, and may be used to exploit the full spectrum of the multimedia device **10** capabilities, while also providing enhancements for gaming and other similar applications. The use of exemplary embodiments of this invention are also well suited for use with Internet browser and similar applications, such as when scrolling through HTML pages and selecting links within a displayed page.

[0049] Note that while the use of one or more fingers has been described above, it is also within the scope of the exemplary embodiments to employ at least in part a stylus or some other object that is held and manipulated by the user in the energy field of the USTs **14**. All such objects, including a human finger or fingers, hand or hands, stick or stylus may be referred to for convenience as a user-manipulated physical object.